

PROTOCOL

ECOLOGICAL RISK-BASED REMEDIAL GOAL OPTIONS

Introduction

The following protocol has been developed in order to support the Savannah River Site (SRS) environmental remediation program. This protocol provides instructions for identification of ecological remedial goal options (ECO RGOs). The protocol instructions are based on the latest available EPA guidance as well as input from the staffs of the Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC). The starting point for this protocol is with the list of preliminary ecological constituents of concern (ECO COCs) developed in the baseline risk assessment (BRA).

Development of ECO RGOs occurs early in the Remedial Investigation / Feasibility Study (RI/FS) and requires the following unit-specific data:

- Media of concern
- Constituents of concern for each assessment endpoint
- Probable future land use

In general, RGOs provide long-term targets to use during analysis and selection of remedial alternatives. RGOs will be determined for the final list of ECO COCs remaining after the uncertainty analysis.

RGOs are developed using literature-based toxicity values (Toxicity Reference Values [TRVs]) or estimated from unit-specific biological data, where applicable. RGO ranges will be calculated using both NOAELs and LOAELs.

Details

A. EXPOSURE MEDIA

RGOs are developed for soil, sediment, and surface water exposure media.

B. ASSESSMENT ENDPOINT

RGOs are developed for those assessment endpoints that have been determined to be appropriate endpoints for the particular waste-unit.

C. EXPOSURE FACTORS

Exposure factors used in the development of RGOs should include the following:

1. Dietary exposure parameters;
2. Bioaccumulation factors (BAFs) and bioconcentration factors (BCFs); and
3. Unit-foraging factors (UFFs).

D. EFFECTS EVALUTION

In order to remediate the environment, protection of the assessment endpoints is critical. As in the ERA, the TRVs obtained from the *Toxicity Reference Values (TRVs)* protocol or from field-derived biological characterization data are considered in evaluating constituent RGOs for the representative ecological receptors.

E. CALCULATIONS

The RGO is the environmental concentration of contaminant when the HQ is 1. Examples of the RGO equations for soil, sediment, and surface water are provided below.

1. Risk-based RGOs for soil

Risk-based RGOs for soil-dwelling receptors (e.g., earthworms) assumed to be exposed directly and continuously to contaminants in soil is derived by:

$$\text{RGO} = \text{TRV}$$

where:

RGO = remedial goal options (mg/kg soil),

TRV = receptor-specific toxicity reference value (mg/kg soil) or unit-specific toxicity data if available.

Risk-based RGOs for herbivores, omnivores, and carnivores are derived from modeled exposure and from receptor-specific toxicity threshold by a rearrangement of the equation for the HQ. The HQ equation is:

$$HQ = ED / TRV$$

where:

HQ = hazard quotient,

ED = exposure dose, receptor-specific exposure to contaminants from soil (mg/kg/d), and

TRV = receptor-specific toxicity reference values (mg/kg/d).

An example of the RGO equation for a higher, trophic level receptor is provided below.

$$RGO = \frac{TRV \times BW}{UFF[(SP \times I_p) + (BAF \times I_a) + I_s]}$$

where:

RGO = remedial goal option (mg/kg soil),

TRV = receptor-specific toxicity reference values (mg/kg/d),

BW = body weight of the receptor (kg),

UFF = Unit foraging factor,

SP = soil-to-plant bioaccumulation factor (kg soil/kg tissue),

I_p = daily ingestion of plant tissue (kg/d),

BAF = soil-to-plant bioaccumulation factor for prey (kg soil/kg tissue),

I_a = daily ingestion of animal tissue (kg/d), and

I_s = daily soil ingestion (kg/d).

2. Risk-based RGOs for sediment

RGOs for sediment are derived using risk-based values because there are no Federal or State applicable and appropriate requirements (ARARs) for sediment. These risk-based values are the TRVs to be identified in the “Aquatic Toxicity Reference Values (TRVs)” protocol. The example sediment RGO equation is provided below.

$$RGO = \frac{BW \times TRV}{UFF \left[\frac{I_w}{K_d} + I_t \times BAF \right]}$$

where:

RGO	=	remedial goal option (mg/kg soil),
BW	=	body weight of the receptor (kg),
TRV	=	receptor-specific toxicity reference values (mg/kg/d),
UFF	=	Unit foraging factor,
I_w	=	daily ingestion of water (L/d),
K_d	=	Distribution coefficient for chemical between concentration in water and concentration in sediment (L/kg),
I_t	=	total ingestion (animal, plant, sediment) (kg/d), and
BAF	=	bioaccumulation factor for food item (kg soil/kg tissue).

3. Risk-based RGOs for surface water

ARARs such as National Ambient Water Quality Criteria (NAWQC) and Tier II Secondary Chronic Values are available for some contaminants in surface water. These values represent the highest environmental concentration at which exposure to contaminants in surface water are not harmful to biological individuals, ecological populations, or communities. When chronic NAWQC and Tier II values are available, these values will be chosen as RGOs for protection of aquatic receptors.

In addition to aquatic receptors, some terrestrial receptors are exposed to contaminants in surface water by ingestion of aquatic receptors and surface water. Risk-based RGOs are developed for the representative receptors that are exposed through the food web to surface water contaminants as shown in the example provided below.

$$RGO = \frac{1000 \times TRV \times BW}{UFF \left[(BCF \times I_t) + (I_w) \right]}$$

where:

- RGO = remedial goal option (ug/L),
 1000 = conversion factor, ug/mg,
 TRV = receptor-specific toxicity reference value (mg/kg/d),
 BW = body weight of the receptor (kg),
 UFF = Unit foraging factor,
 BCF = water-to-fish prey bioconcentration factor (L/kg tissue),
 I_t = daily ingestion of total food (animal and plant) (kg/d),
 and
 I_w = daily drinking water ingestion (L/d).

The following example table should be included with the RGO chapter:

Media	Receptor	Constituent	RGO Range	MR RGO ¹	HQ Basis

¹ MR RGO = Most restrictive RGO.